May 16, 1939. F. C. BIGGERT, JR., ET AL 2,158,687

METHOD AND APPARATUS FOR TREATING METAL

Filed May 29, 1936 6 Sheets-Sheet 1

Fig. 1

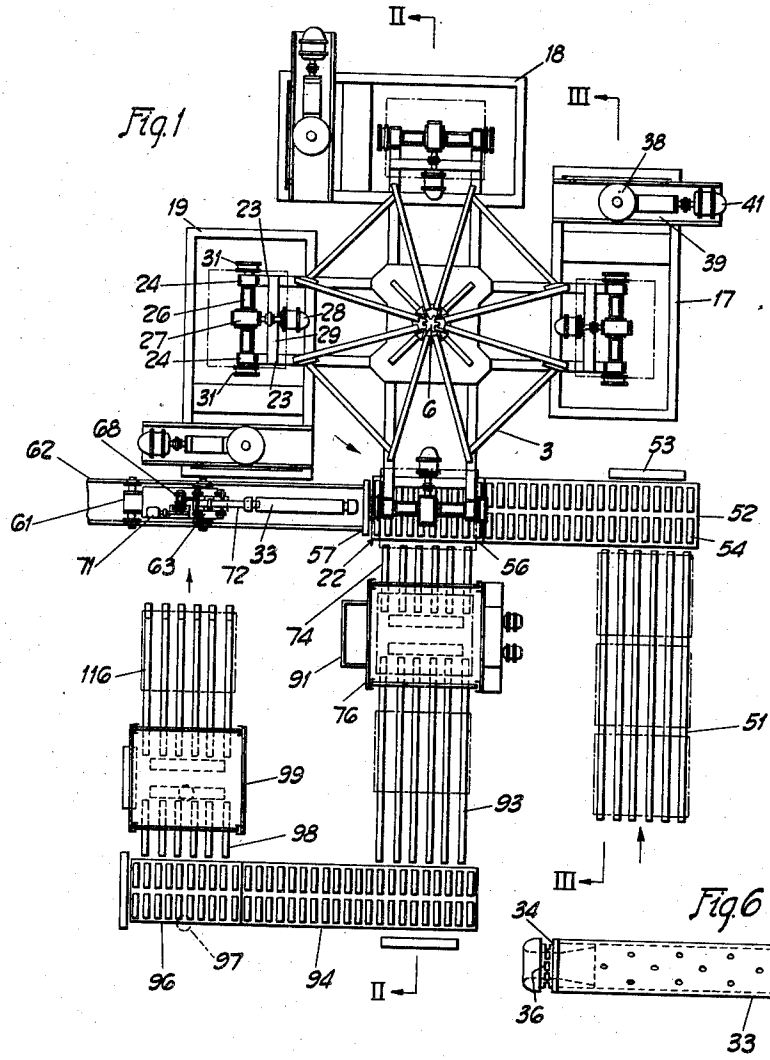
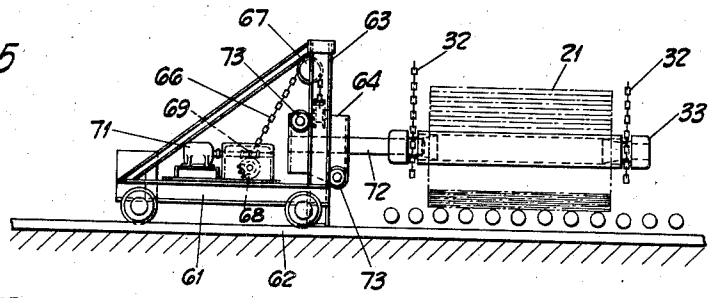


Fig. 6

Fig. 5



WITNESSES
V. A. Peckham
E. O. Johns

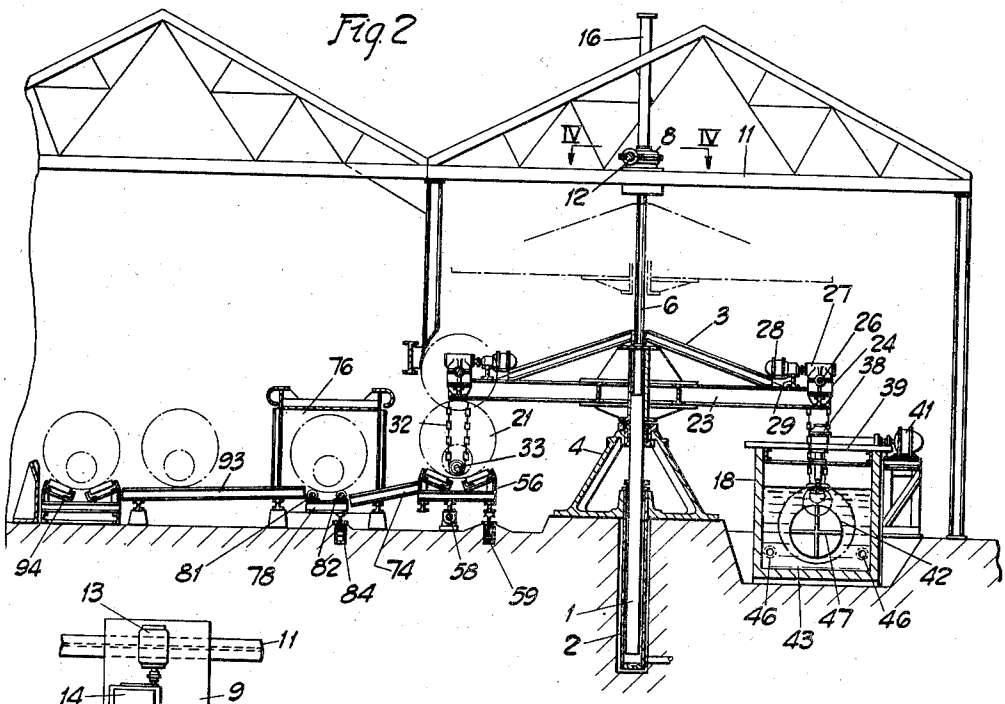
INVENTORS
Florence C. Biggert, Jr.
Charles F. Bubbe
BY
Brown, Critchlow & Flick
ATTORNEYS

May 16, 1939. F. C. BIGGERT, JR., ET AL 2,158,687

METHOD AND APPARATUS FOR TREATING METAL

Filed May 29, 1936 6 Sheets-Sheet 2

Fig. 2



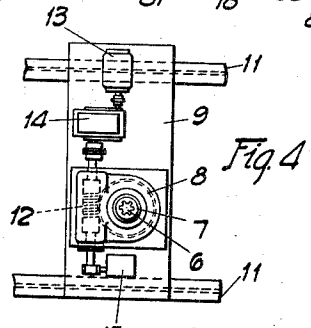


Fig. 4

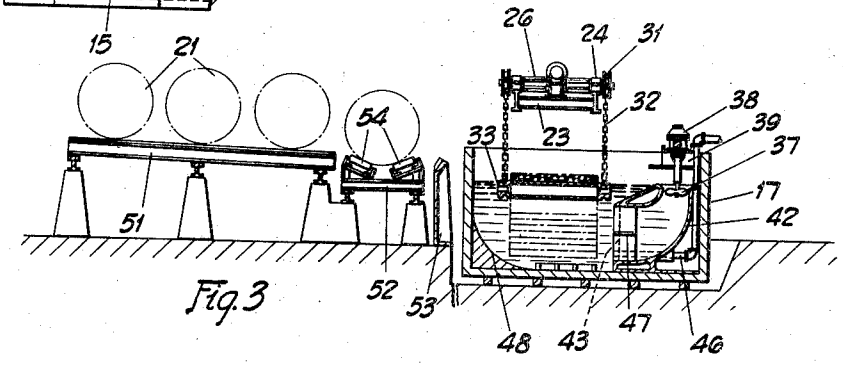


Fig. 3

WITNESSES
V. A. Peckham
E. O. Johns

INVENTORS:
Florence C. Biggert, Jr.
Charles F. Biggert
BY
Brown, Critchlow & Flick
ATTORNEYS.

May 16, 1939. F. C. BIGGERT, JR., ET AL 2,158,687

METHOD AND APPARATUS FOR TREATING METAL

Filed May 29, 1936 6 Sheets-Sheet 3

Fig. 7

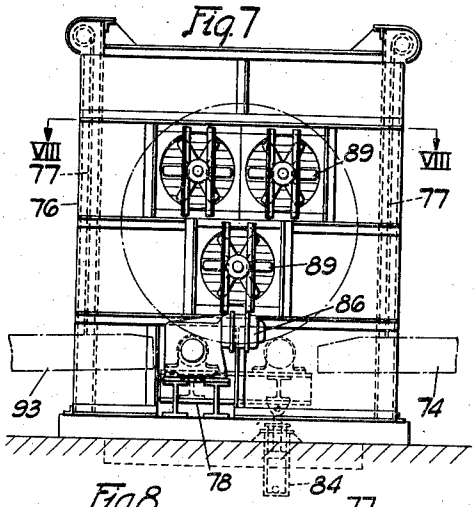


Fig. 10

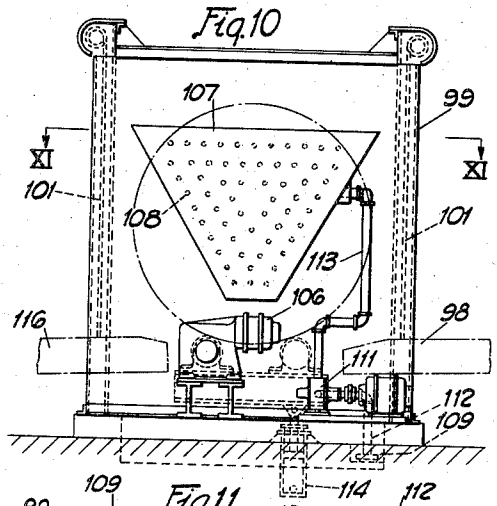


Fig. 8

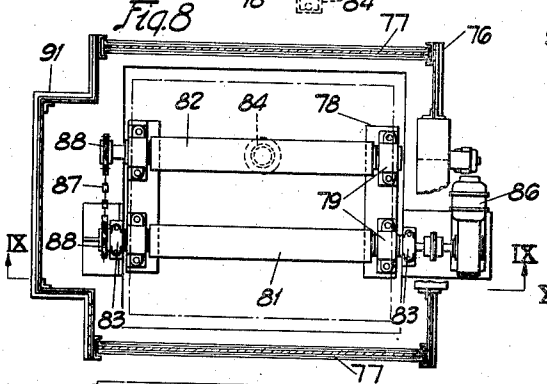
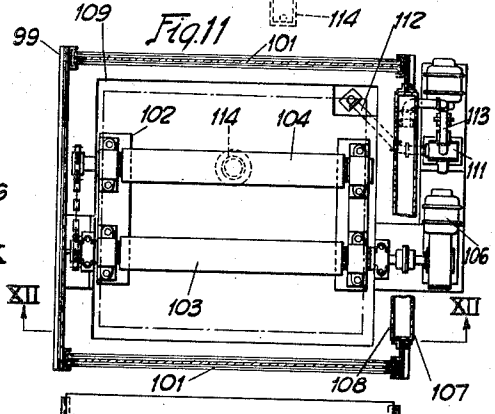


Fig. 11



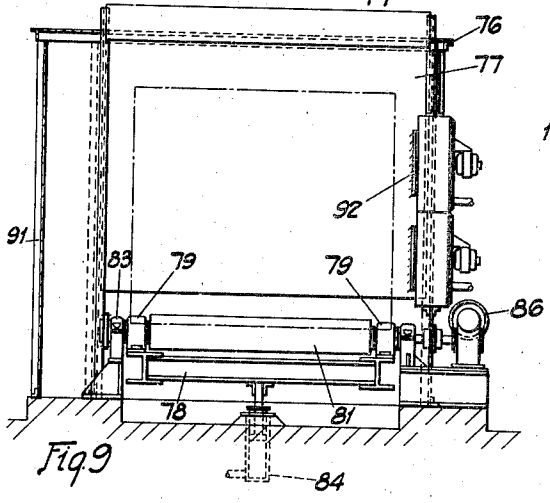


Fig. 9

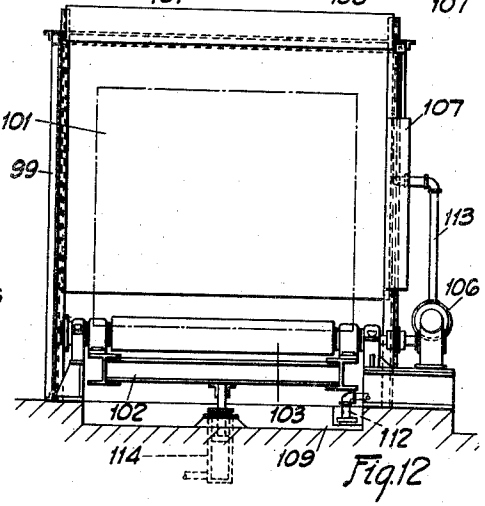


Fig. 12

WITNESSES

V. A. Peckham

E. O. Johns

INVENTORS:

Florence C. Biggert Jr

Charles F. Krente

BY

Brown, Critchlow & Flick

ATTORNEYS

May 16, 1939. F. C. BIGGERT, JR., ET AL 2,158,687

METHOD AND APPARATUS FOR TREATING METAL

Filed May 29, 1936 6 Sheets-Sheet 4

Fig.14

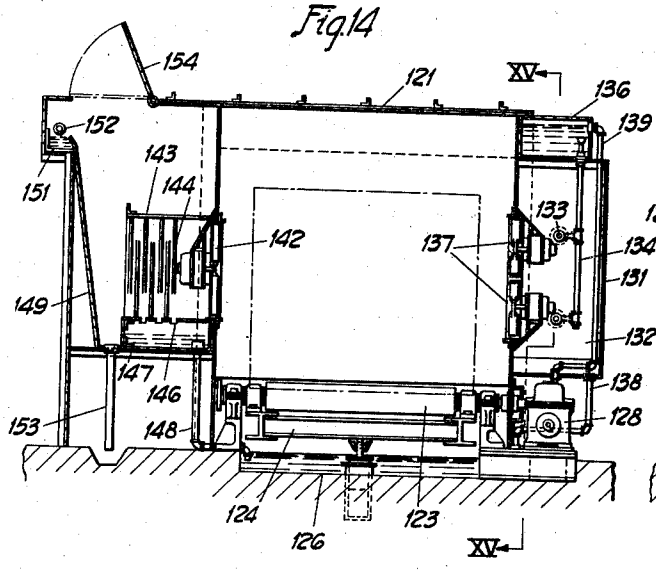


Fig.15

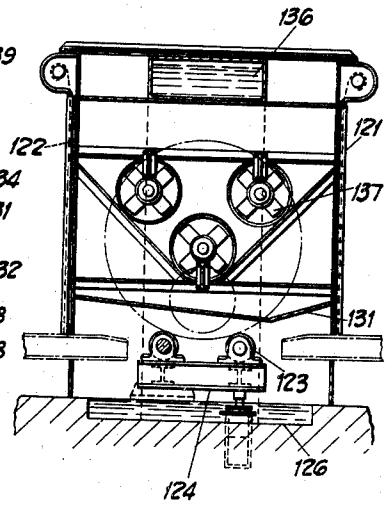


Fig.13

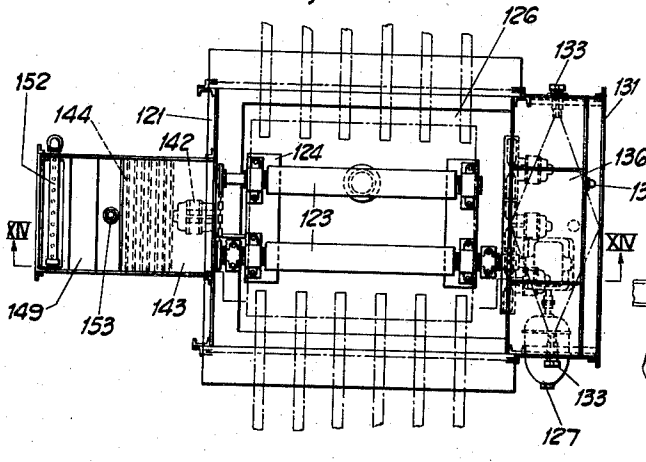
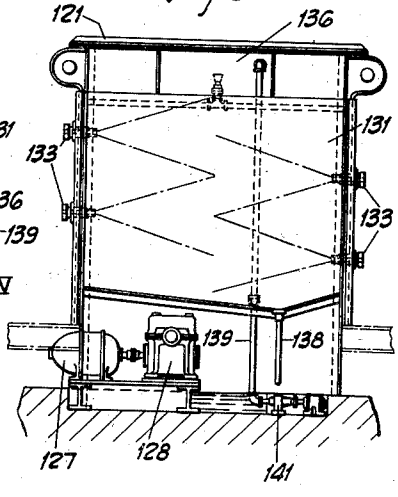


Fig.16



WITNESSES

V. A. Peckham

E. O. Johns

INVENTORS:

Florence C. Biggert Jr

Charles F. Buente

BY

Brown, Critchlow & Flick

ATTORNEYS

May 16, 1939. F. C. BIGGERT, JR., ET AL 2,158,687

METHOD AND APPARATUS FOR TREATING METAL

Filed May 29, 1936 6 Sheets-Sheet 5

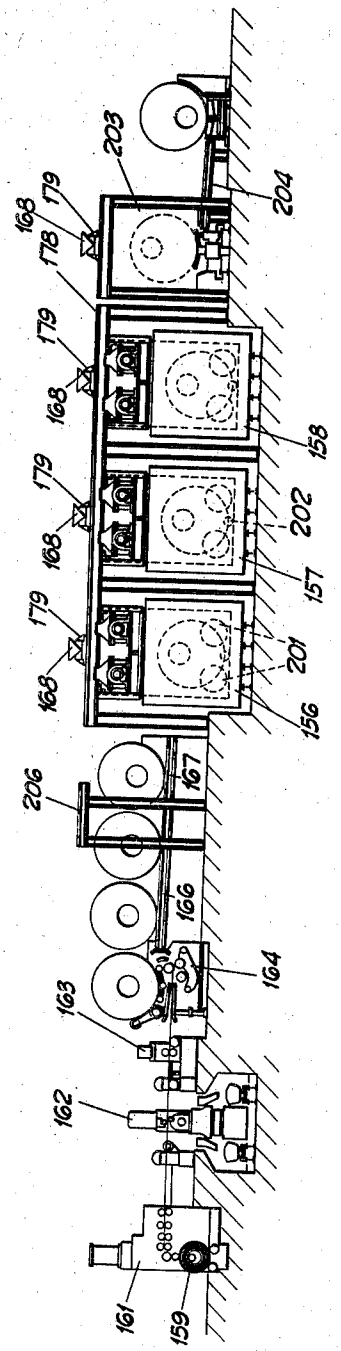


Fig. 17

WITNESSES
V. A. Peckham
E. O. Johns

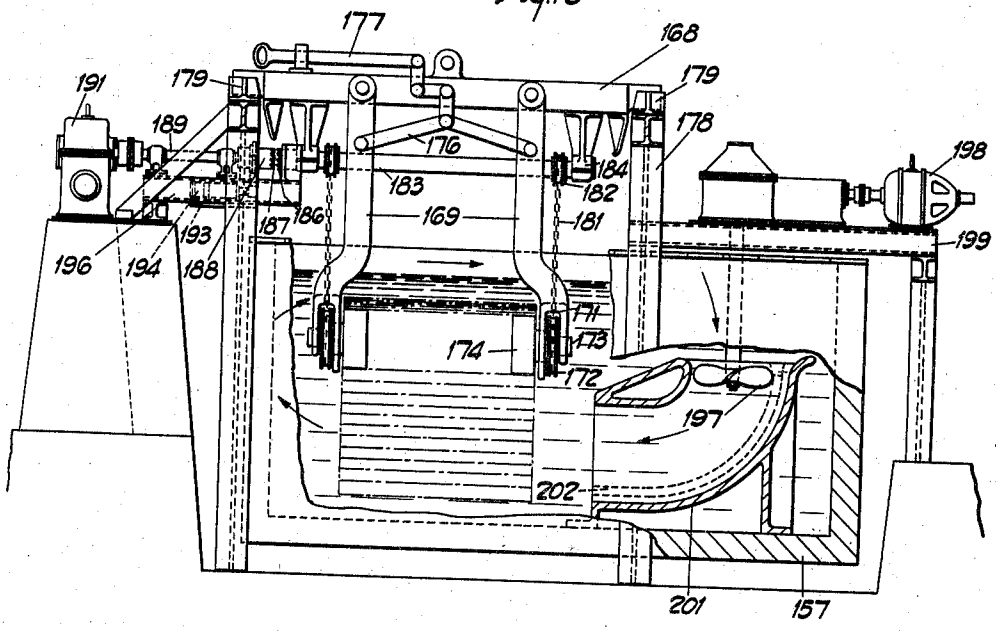
INVENTORS:
Florence C. Biggert Jr.
Charles F. Billute
BY
Brown, Critchlow & Flick
ATTORNEYS

May 16, 1939. F. C. BIGGERT, JR., ET AL 2,158,687

METHOD AND APPARATUS FOR TREATING METAL

Filed May 29, 1936 6 Sheets-Sheet 6

Fig. 19



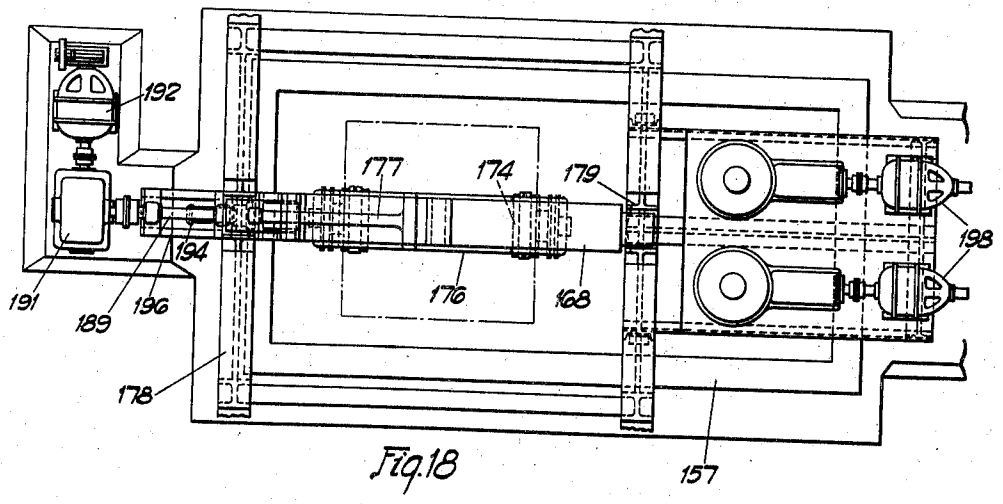


Fig. 18

WITNESSES

V. A. Peckham

E. O. Johns

INVENTORS

Florence C. Biggert, Jr.

Charles F. Billante

BY

Brown Critchlow & Flick

ATTORNEYS

Patented May 16, 1939 2,158,687

UNITED STATES PATENT OFFICE

2,158,687

METHOD AND APPARATUS FOR TREATING METAL

Florence C. Biggert, Jr., Crafton, and Charles F. Buente, Pittsburgh, Pa., assignors to United Engineering & Foundry Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application May 29, 1936, Serial No. 82,542

9 Claims. (Cl. 148—4)

This invention relates to a method and apparatus for treating metal with a fluid, and more particularly to the pickling and preservation of coils of metal.

It is among the objects of this invention to provide a method and apparatus for treating metal in a bath according to which the metal is thoroughly treated in a minimum length of time, and for properly protecting the metal after removal from the bath. Other objects are to provide apparatus which is relatively compact and simple in construction and operation for carrying out this invention.

According to this invention there is provided a plurality of metal-treating tanks for receiving treating baths and the articles to be treated. In the preferred embodiment the tanks and a loading and unloading station are arranged around and substantially equidistant from the vertical axis of rotation of a rotatable and vertically movable frame or spider disposed above the tanks. This spider is provided with a plurality of carriers so arranged that when any carrier is above the loading station there is also a carrier above every tank. Each carrier is preferably adapted to support and rotate a coil of metal strip in each tank when the spider is in its lower position. The metal strip is formed into a loose coil so that its convolutions spread apart, and the bath in each tank is positively circulated between the spaced convolutions of the coil as it is rotated therein so that the bath quickly and effectively reaches the entire area of the strip. Preferably, means is provided for directing the circulating bath into the coil.

Means for conveying coils to and from the loading station, and for further treating them after they have left the tanks, are also provided. The conveying means may take the form of skids or gravity conveyors, or of a combination of the two, and the further treatment preferably comprises drying the coil while it is being rotated with its convolutions spaced apart, and then spraying it with a protecting coat of oil while it is being rotated in the same manner.

If desired, the several tanks can be arranged side by side in a straight line, in which case a monorail system or a traveling crane may be used for transferring the coils from one tank to another.

Apparatus for practicing the invention is illustrated in the accompanying drawings in which Fig. 1 is a plan view of the preferred embodiment; Fig. 2 is a vertical section of the apparatus taken on the line II—II of Fig. 1; Fig. 3 is a vertical section taken on the line III—III of Fig. 1; Fig. 4 is an enlarged plan view of the spider-rotating mechanism taken on the line IV—IV of Fig. 2; Fig. 5 is an enlarged side view of mandrel-charging apparatus used in the apparatus; Fig. 6 is an enlarged side elevation of a coil-supporting mandrel; Fig. 7 is an end view of coil-drying apparatus; Fig. 8 is a horizontal section taken on the line VIII—VIII of Fig. 7; Fig. 9 is a vertical section taken on the line IX—IX of Fig. 8; Figs. 10, 11 and 12 are views similar to Figs. 7, 8 and 9, respectively, of coil-oiling apparatus; Fig. 13 is a plan view, with the top removed, of a modification of the oiling apparatus; Fig. 14 is a vertical section thereof taken on the line XIV—XIV of Fig. 13; Fig. 15 is a transverse section taken on the line XV—XV of Fig. 14; Fig. 16 is an end view of the oiler of Fig. 14; Fig. 17 is a side elevation of a modification of this invention; Fig. 18 is a plan view of one of the tanks shown in Fig. 17; and Fig. 19 is a side view of one of the tanks partly broken away to show it in vertical section.

Referring to Fig. 2 of the drawings, an upright plunger 1 is slidably disposed in a cylinder 2 sunk in a suitable foundation. Rigidly mounted on the upper end of the plunger is a skeleton frame or spider 3 that normally rests on a supporting guide 4 for the plunger above the cylinder. However, when desired the spider can be elevated by any well-known means; for example, by fluid pressure in the cylinder below the plunger, the pressure being furnished in any suitable way, such as by a hydraulic pump and accumulator (not shown).

In order to rotate the spider, a mast 6 is rigidly connected to the upper end of plunger 1 from which it extends upwardly through a gear 7 in a gear housing 8 mounted on a suitable support 9 that may conveniently be attached to the overhead beams 11 of the building housing this apparatus, as shown in Figs. 2 and 4. The mast is splined in the gear to permit the mast to move vertically through it and to likewise be rotatable by the gear which is turned by a worm 12 driven by a motor 13 through a speed-reducing unit 14. The spider-rotating apparatus is connected to a limit switch 15 which always stops the rotation of the spider in the correct positions relative to a plurality of tanks below it. In case the mast projects above the roof of the building when in its upper position, it can be enclosed and protected by a tube 16.

Although the apparatus disclosed herein can be used for treating metal articles of various

types and shapes, it is especially suitable for the pickling and handling of coils 21 of metal strip indicated diagrammatically in the drawings by broken lines. For this purpose three treatment tanks are sufficient, tank 17 containing a pickling bath, tank 18 cold rinse water, and tank 19 hot rinse water. As shown in Fig. 1, these tanks are all spaced the same distance from plunger 1, tanks 17 and 19 preferably being opposite each other with tank 18 between them and opposite a combined loading and unloading station 22. With three treating tanks and station 22, it is desirable that the spider be provided with four carriers for coils of strip so that it can support a coil in each tank while a coil at the station is being picked up by the spider or deposited thereby.

Accordingly, the spider preferably comprises four pairs of horizontal beams 23 extending radially from the plunger at 90° intervals. Mounted on the outer ends of each pair of beams are bearings 24 in which a shaft 26 is journaled. Each of these shafts is rotated through a speed reduction unit 27 operatively connected thereto and to a motor 28 mounted on a cross-beam 29 secured to the adjoining pair of main beams. Mounted on the projecting ends of each shaft 26 are sprocket wheels 31 from which endless chains 32 are suspended, as shown in Fig. 3. Carried in the lower loops of each pair of chains is a coil-supporting member, such as a mandrel 33 that is preferably tubular and provided near each end with an annular groove 34 the inner wall of which is provided with a series of recesses 36 (Fig. 6) adapted to receive alternate links of one of the chains 32 like a sprocket so that the rotation of shaft 26 on the spider will be transmitted by the chains to the mandrel and the coil supported thereby.

It is a feature of this invention that the treating baths in the tanks are rapidly brought into contact with the entire surface area of the strip forming the coils. Accordingly, the coils are loosely formed so that when supported by the mandrels the lower portions of their convolutions spread apart, and the baths are positively circulated through the coils between their spaced convolutions as the coils are rotated. As shown in Figs. 2 and 3, this circulation is preferably accomplished by means of a propeller blade 37 extending downwardly into the treating bath at one end of each tank where it is driven through a gear housing 38, mounted on a support 39 above it, by a motor 41 at one end of the support.

The rotating propeller sets the bath in motion, but to direct the circulation in a well-defined path in which the coil is disposed, an upwardly curved tubular member 42 is preferably mounted in the tank with its outlet end positioned adjacent one end of the coil and its inlet end surrounding the propeller blade (Fig. 3). The space between the outlet end of the tubular member and the sides of the tank is closed by a vertical plate 43 so that the bath can not circulate along the sides of the tube but must pass through it, but there is no such plate adjoining the inlet of the tube. The reasons for the absence of a plate in that location are to reduce vortexing into the tube which would entrain air and decrease the speed of circulation of the bath, and to permit the bath to freely circulate to the inlet ends of conventional type steam jets 46 mounted in the lower portion of plate 43 on both sides of tube 42 in the pickling and hot water tanks where they keep the baths hot. By making the inlet end of tube 42 smaller than its outlet end, a smaller propeller and less power can be used than if both ends are the same size. To aid in directing the bath as it leaves the tube, its outlet end can be subdivided into segments by intersecting vanes 47 secured therein. Eddying and surging of the bath at the opposite end of the tank is greatly diminished by curving its bottom at 48 to eliminate the right-angle turn.

Coils 21 of metal strip are preferably delivered to and from loading and unloading station 22 by a gravity conveyor system. Although the conveyors can be arranged in any suitable manner, and will be arranged to meet local conditions such as the shape of the building in which the apparatus is housed, a compact conveyor system is shown in Fig. 1. In this arrangement the coils of loosely wound strip are delivered by any suitable means to the upper end of an inclined table 51, formed of skids, which is disposed at right angles to the upper end of a V-type gravity roller table 52 in line with the mandrel 33 at the loading station. As each successive coil rolls down the skids and onto the roller table it is stopped by a guard 53, whereupon the coil moves axially over rollers 54 of the roller table until it is stopped on a receiving table 56 at the loading station by a guard 57. As shown in Fig. 1, the receiving table is a continuation of, but separate from, roller table 52, and, as shown in Fig. 2, is tiltable laterally on a support 58 by suitable means, such as a fluid pressure cylinder 59.

When an untreated coil comes to rest on receiving table 56, mandrel 33 is moved into the coil by charging apparatus at the foot of the table. Although this charging apparatus may be of any form capable of inserting a mandrel in the coil, a simple and effective charger is shown in Figs. 1 and 5 which comprises a carriage 61 movable toward and away from the table on tracks 62. At the front end of the carriage is a pair of spaced vertical uprights 63 between which a block 64 is adapted to be moved vertically by a chain 66 passing over a pulley 67 and extending downwardly to a drum 68 rotatably mounted on the carriage where it is turned by a worm 69 driven by a motor 71. Projecting forwardly from block 64 is a ram 72 which is adapted to project into one end of the tubular mandrel for supporting it. To prevent the weight of the mandrel from tipping the block, wheels 73 are journaled in it for engaging the front and rear sides of the uprights.

When a coil is about to be connected to the lowered spider, chains 32 of the empty carrier extend nearly to the bottom of the coil at both ends so that the mandrel projecting from the charging ram enters the chain loops when it is moved forward into the coil by carriage 61. After the mandrel has been properly positioned relative to the coil and chains, the ram is lowered by the block until the weight of the mandrel is supported by the chains in grooves 34, whereupon the carriage is backed up to withdraw the ram from the mandrel. Thereafter, when the spider is elevated, the mandrel at the loading station raises the coil free of the receiving table prior to its being carried to pickling tank 17.

Every time a coil is carried from the loading station to the pickling tank another coil is carried by the spider from hot water tank 19 to the receiving table 56 which then becomes an unloading station. To remove the mandrel from this pickled coil the charger is moved forward until ram 72 enters the mandrel. The ram is then

raised by chain 66 to free the mandrel of chains 32, whereupon the charger is backed up to withdraw the mandrel from the coil and chain loops. The receiving table is then tilted away from plunger 1 by cylinder 59, and the pickled coil rolls off the table and down a set of skids 74 and preferably into a drying chamber.

According to this invention the drying chamber, shown in Figs. 1, 2, 7, 8 and 9, is preferably formed by a housing 76, two opposite sides of which are provided with vertically sliding doors 77. Disposed in the lower part of the chamber is a frame 78 on the ends of which are mounted two pairs of bearings 79 in which a pair of parallel rollers 81 and 82 are journaled (Fig. 8). The ends of roller 81 project outwardly beyond bearings 79 and into bearings 83 rigidly mounted on the base of the housing. With the axis of roller 81 as its pivot axis, the side of frame 78 nearest the loading station can be raised and lowered by well-known means, such as fluid pressure cylinder 84 (Fig. 7). Before a treated coil rolls down skids 74 and into housing 76, cylinder 84 is caused to lower the side of the frame which it supports so that when the coil rolls onto the rollers, roller 81, which is higher, forms a backstop which stops the coil. The roller frame is then brought into a horizontal position by the cylinder and both doors of the housing are closed. The coil is rotated on the rollers by the rollers themselves, roller 81 being driven by a motor 86 at one end of the housing, while the other roller is driven from the first by a chain 87 and sprockets 88.

As the coil is rotated, the upper portions of its convolutions spread apart, and air is blown across the strip between the spaced convolutions by electric blowers 89 (Fig. 7) mounted in openings in one end of the housing. As the air currents leave the coil they escape from the housing through the top of an offset portion 91 at the end opposite to the blowers. Drying of the coils is hastened by heating the air blown through them, such as by placing a radiator grid 92 or the like (Fig. 9) in front of each blower and passing steam or other heating mediums through it so that the air is heated in passing through the grid.

After a coil has been thoroughly dried the housing door farthest from the loading station is opened and the roller frame is tilted upwardly by cylinder 84 until the coil rolls off the rollers and onto the upper end of an inclined skid table 93 by which it is conducted to the upper end of a gravity roller table 94 disposed at right angles to table 93, as shown in Figs. 1 and 2. At the lower end of this roller table there is a transfer table 96 (Fig. 1), similar to receiving table 56, which can be tilted laterally by a fluid pressure cylinder 97 indicated in dotted lines in Fig. 1. When this table is tilted, a coil thereon rolls off its side and onto inclined skids 98 and into an oiling chamber formed by a housing 99, of the same general type as the drier, having vertically sliding doors 101.

This housing, shown in Figs. 1, 10, 11 and 12, is likewise provided in its lower portion with a tiltable frame 102 on which a pair of rollers 103 and 104 that are driven by a motor 106 are journaled for rotating the coil while in the chamber to cause successive portions of its convolutions to spread apart. While the coil is rotating, oil is sprayed across the strip between its spaced convolutions, such as by means of a tank 107 mounted in one end wall of the housing and having a plurality of perforations 108 in its inner side. As the upper portion of the coil presents the largest number of surfaces to the oil spray, the oil tank may be made of generally triangular form with its widest part at the top, as shown in Fig. 10. Oil is pumped into this tank from a sump 109 in the bottom of the housing by means of a pump 111 and conduits 112 and 113, and the pressure built up in the tank by the oil pump forces the oil out of the tank through the perforations in sprays which coat the strip between the convolutions of the coil.

After the coil has been thoroughly oiled, roller frame 102 is tilted by fluid pressure cylinder 114 to cause the coil to roll out of the housing and onto inclined skids 116 over which it rolls to a point from which it can be removed by a crane or other suitable apparatus for storage.

To use this apparatus described thus far, coils of loosely wound metal strip are delivered to skid table 51 down which they roll to roller table 52 by which they are conveyed to receiving table 56 one at a time. When a coil comes to rest on the receiving table the mandrel charger is moved toward it to insert a mandrel 33 in the coil and chains 32. After the charger has been withdrawn, fluid pressure is admitted to the bottom of plunger cylinder 2 to raise the spider and all of the coils carried thereby above the receiving table and the treating tanks. The spider is then rotated 90° by gear 7 in which mast 6 is splined, whereby the new coil is brought to a position above pickling tank 17, the preceding two coils are stopped above the other two tanks, and the coil that left the hot rinsing tank 19 moves to station 22. Thereupon the spider is lowered to immerse three coils in the baths in the underlying tanks, and to deposit the remaining coil on receiving table 56. The mandrel in this last coil is then removed by the charger, and the table is tilted to cause the coil to roll into the drying chamber.

While the pickled coil is being removed from the spider the coils in the tanks are rotated by their supporting mandrels from motors 28 on the spider, and the baths in the tanks are circulated through the coils between their spaced convolutions by the propellers 37. While the coils are being treated in the tanks a new coil moves onto the receiving table and is charged with the mandrel removed from the preceding coil. The spider is then elevated and turned and the cycle repeated. By this time the coil in the drier is dry and is conveyed by the connecting tables to the oiling chamber, while the following coil is removed from the spider and rolled into the drier.

It will thus be seen that the coils are thoroughly treated in the tanks and in the drier and oiler because the treating fluids are positively circulated across the surfaces of the strips between their spaced convolutions while they are rotating. The rotation hastens the process by continuously presenting new surfaces to the action of the treating fluids. In spite of the many operations efficiently performed by this apparatus in a short time, the apparatus does not require a comparatively great amount of space and is not excessively complicated or expensive.

In Figs. 13 to 16 there is shown a modified embodiment of the coil-oiling apparatus. Like the oiler previously described, this one has a housing 121 with vertically sliding doors 122 in its opposite sides and with a pair of rollers 123 journaled in a tiltable frame 124 mounted above a sump 126. The rollers are driven by a motor 127 through a reduction unit 128.

Attached to one end of the housing is a casing 131 forming a spray chamber 132. Mounted in the sides of the casing are oil atomizing nozzles 133 preferably disposed in staggered relation, as shown in Fig. 16, so that the oil sprays therefrom will be distributed quite uniformly throughout the chamber. The nozzles are connected to any suitable source of compressed air, and oil is supplied to them through pipes 134 from an oil reservoir 136 on top of casing 131. To carry the atomized oil in the spray chamber into a coil of loosely wound strip being rotated by rollers 123, a plurality of electric blowers 137, preferably three arranged as shown in Fig. 15, are mounted in openings in the end wall of the housing. These blowers draw the atomized oil out of chamber 132 and blow it between the spaced convolutions of the rotating coil. The oil that drains into the sump from the coil, and from casing 131 through drain pipe 138, is pumped back into the oil reservoir through pipe 139 by an oil pump 141.

The opposite end of the housing is provided with an opening in line with the coil in which an exhauster 142 is mounted for drawing the excess oil spray out of the oiling chamber. The exhauster preferably forces the oil-laden air into a box-like member 143 in which a plurality of partially overlapping baffle plates 144 is mounted for collecting the oil so that it will drain out through bottom openings 146 and into a pan 147. The pan is connected by a pipe 148 to the sump. The oil that passes the baffles with the carrier air strikes against a sharply inclined board 149 down which a film of water flows continuously from a tank 151 supplied by a perforated water pipe 152. The film of water washes the oil out of the carrier air, and the water and oil drain out as waste through a drain pipe 153. The air, by this time substantially free from oil, escapes through a top door 154.

In the modification shown in Fig. 17 the coil-treating tanks 156, 157 and 158 are disposed side by side in a straight line instead of in a circle, and the loading and unloading stations are at opposite ends of the apparatus. Tightly wound coils 159 of metal strip are unwound by unwinding apparatus 161, the strip passes through a combined end shear and welder 162 and on through pinch rolls 163 to a loose coil former 164 of conventional form. From this latter machine the coils are rolled onto inclined skids 166 down which they roll to a loading station 167 where each successive coil is picked up by a carriage suspended from any suitable overhead traveling member, such as a crane or a monorail conveyor, to convey them to the opposite end of the apparatus.

As shown in Fig. 19 the carriage preferably comprises a horizontal beam 168 to which are pivoted the upper ends of a pair of depending arms 169 the lower ends of which are bifurcated to form recesses 171 in which sprockets 172 are rigidly mounted on shafts 173 journaled in the arms. The inner end of each of these shafts supports a stub mandrel 174 that projects into the coil to support it. To grip or release a coil the stub mandrels are moved toward and away from each other in any suitable manner, such as by a toggle mechanism 176 connected to the arms and beam 168 and operated by a rod 177 slidably mounted on top of the beam.

To rigidly support beam 168 above each tank so that the coil carried thereby will be immersed in the bath in the tank, a framework 178 is constructed above the tanks, and a pair of socket members 179 is secured to the top of this framework above each tank for snugly receiving the ends of the beam. The coil is rotated in the tanks by the stub mandrels which are turned by sprockets 172 driven by endless chains 181 from sprockets 182 keyed on a shaft 183 journaled in bearings 184 projecting downwardly from the supporting beam. One end of this shaft is provided with teeth 186 adapted to be engaged by complementary teeth 187 on the end of a clutch sleeve 188 which is splined on the inner end of a drive shaft 189 driven through a speed reduction unit 191 by a motor 192 mounted outside of the tank. When the coil carriage is lowered into a tank with teeth 186 in line with teeth 187, the clutch sleeve is moved forward to cause the two sets of teeth to register, and the motor is started, whereupon shaft 183, the stub mandrels and the coil are rotated.

The clutch sleeve can be moved into and out of operative position by any suitable means, a convenient way of doing this being by means of a piston 193 connected to the bottom of the clutch and actuated by fluid pressure in a cylinder 194 mounted in a support 196 below drive shaft 189. Fluid pressure can be admitted to the cylinder in any suitable way, automatically or otherwise. If desired, the weight of the carriage as it is lowered into a tank can be used to set piston 193 in motion, or the same thing can be accomplished by a photo-electric cell on which shines a beam of light that is broken by the lowered carriage.

Each of the treating tanks is provided with means for positively circulating the bath between the spaced convolutions of a coil rotating therein. Although the circulating means may be the same as that described in connection with the first embodiment, a modification of this means is shown which is especially suitable for use in large tanks in which large coils are treated. In this embodiment two propellers 197 extend downwardly into the bath at one end of the tank and are driven from above by a pair of motors 198 mounted on suitable supports 199. These propellers are disposed side by side and the circulating bath is directed into the coil by a pair of upwardly curved tubular members 201 likewise disposed side by side with their outlets adjacent one end of the coil and their inlets receiving the propellers. A steam jet 202 for heating the bath is preferably disposed between the tubular members. With the use of two propellers and tubes the entire bath throughout the width of a wide tank is set in motion and circulated through a coil in its path.

After a coil has been treated in each of the tanks it is set down by the carrier in a drying chamber 203 of any suitable construction, and the stub mandrels are spread apart to release the coil. When the coil is dry it is rolled out onto an inclined table 204 from which it is delivered to an oiler or to a storage point.

Upon being released from the coil, the carrier is transported from the drying chamber back to a point adjacent the loading station where it may be temporarily deposited on a frame 206 while the immediately preceding carrier is picking up a coil at the loading station. It will be understood, of course, that several carriers are in use at once so that coils will be disposed in all of the tanks and the drier at the same time.

According to the provisions of the patent statutes, we have explained the principle and operation of our invention and have illustrated and

described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. Metal-treating apparatus comprising a tank for receiving a metal-treating bath, means for rotating a coil of metal therein on a substantially horizontal axis, means for circulating said bath in said tank, and means for directing said circulating bath through said coil, the bottom of the tank at the end opposite to said directing means being curved upwardly to direct said bath in an upwardly curved path without substantial eddying.

2. Metal-treating apparatus comprising a tank adapted to receive a metal-treating bath and metal to be treated, a propeller blade disposed in said tank, means for driving said blade for circulating said bath in the tank, a tubular member mounted in said tank with one end adjacent said propeller blade and the other end adjacent said metal whereby said bath is circulated through said member and directed across said metal, and plates closing the space between the outlet of said tubular member and the sides of the tank.

3. Metal-treating apparatus comprising a tank adapted to receive a metal-treating bath and metal to be treated, a propeller blade disposed in said tank, means for driving said blade for circulating said bath in the tank, a tubular member mounted in said tank with one end adjacent said propeller blade and the other end adjacent said metal whereby said bath is circulated through said member and directed across said metal, the end of said member adjacent said blade being materially smaller than its outlet end, and means mounted in the outlet end of said tubular member for dividing it into channels to direct the bath in predetermined paths across the tank.

4. Metal-treating apparatus comprising a tank for receiving a metal-treating bath, rotatable means mounted above said tank, endless chains suspended from said means, a mandrel supported by said chains below said means, means for rotating said rotatable means to impart rotation to the mandrel, said mandrel being adapted to extend through a loose coil of metal and support it in said tank with portions of its convolutions spaced apart, and a vertically movable support disposed at one side of said rotatable means and rigidly connected thereto for moving said mandrel into and out of said tank.

5. The method of treating metal strip, comprising forming a loose coil of said strip, supporting said coil in a metal-treating bath with a portion of its convolutions spread apart, rotating the coil in said bath to cause successive portions of its convolutions to spread apart, positively circulating said bath transversely across said strip between said spaced convolutions, removing the coil from the bath, circulating warm air between said convolutions to dry the coil, and spraying oil between said convolutions to oil the strip.

6. Metal-treating apparatus comprising a tank for receiving a metal-treating bath, a mandrel for supporting a coil of metal in said tank, mandrel-carrying means for transporting said mandrel and coil between a loading and unloading station and said tank, a carriage disposed adjacent said station and movable axially of said mandrel, and means mounted on said carriage and adapted to connect with the mandrel for removing it from treated coils and inserting it in untreated coils.

7. Metal-treating apparatus comprising a tank for receiving a metal-treating bath, a mandrel for supporting a coil of metal in said tank and having an axial opening in one end, a carrier, chain loops suspended from said carrier for receiving and supporting the mandrel, means for moving the carrier to transport the mandrel and coil between a loading and unloading station and said tank, a carriage disposed adjacent said station and movable axially of said mandrel, a ram projecting from the carriage toward said station and being adapted to enter said mandrel opening for supporting the mandrel, and means mounted on said carriage for raising the ram to free the mandrel of said chain loops whereby the mandrel is movable axially of said coil by the carriage and ram.

8. Metal-treating apparatus comprising an upright mast, means for moving the mast vertically, an arm projecting laterally from the mast, a substantially horizontal shaft carried by said arm, means for rotating the shaft, a plurality of open tanks disposed around said mast, means for indexing the mast to carry said shaft to and from positions above successive tanks, a pair of endless chains suspended from said shaft and adapted to be driven thereby, and a mandrel supported by the chains for rotation thereby, said mandrel being adapted to rotatably support a coil of metal strip in each successive tank when lowered therein by said mast.

9. Metal-treating apparatus comprising an upright mast, means for moving the mast vertically, an arm projecting laterally from the mast, a substantially horizontal shaft carried by said arm, means for rotating the shaft, a plurality of open tanks disposed around said mast, means for indexing the mast to carry said shaft to and from positions above successive tanks, a pair of endless chains suspended from said shaft and adapted to be driven thereby, a mandrel supported by the chains for rotation thereby, said mandrel being adapted to rotatably support a coil of metal strip in each successive tank when lowered therein by said mast, and means disposed in each of said tanks for positively circulating fluid therein through a coil rotated therein by said mandrel.

FLORENCE C. BIGGERT, JR.
CHARLES F. BUENTE.